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**DATE:** March 10, 2014

**SUBJECT:** Agency Activities in Seawater and Brackish Groundwater Desalination

## **ACTION REQUESTED**

Briefing and discussion on agency activities in seawater and brackish groundwater desalination

## **BACKGROUND**

Desalination as an alternative water supply has been receiving increased attention in Texas in recent years because of dwindling fresh water supplies caused by the pervasive ongoing drought in the state. Texas is ideally suited for desalination. The 360-mile-long coastline along the Gulf of Mexico provides access to a limitless supply of seawater for Texans, approximately two-thirds of who live within 150 miles of the coast. Inland, 30 aquifers spread across the state contain brackish groundwater estimated to total more than 2.7 billion acre-feet. Furthermore, experience gained from the growing number of successful desalination projects such as the Kay Bailey Hutchison and the Southmost Regional Water Authority brackish groundwater desalination plants has helped spur desalination activity in the state.

Over the past decade, the Texas Water Development Board (TWDB) has been at the forefront of the state's efforts to promote seawater and brackish groundwater desalination and to identify and address challenges to implementing this water supply solution. Pursuant to Texas Water Code §16.060, the TWDB is required to biennially report on the progress made towards implementing seawater desalination in Texas. To promote seawater desalination, the 78<sup>th</sup> and 79<sup>th</sup> Texas legislatures appropriated \$4 million for feasibility studies, a pilot plant project, and

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other related studies. Additionally, the 78<sup>th</sup>, 79<sup>th</sup>, and 80<sup>th</sup> Texas legislatures appropriated a total of about \$2.6 million to TWDB for grants for brackish groundwater desalination demonstration projects and other related activities.

In total, since 2000, the TWDB has awarded approximately \$7.1 million in grants<sup>1</sup> for 30 desalination related projects (see Attachment: Desalination Projects Funded by the Texas Water Development Board). Presently, the TWDB does not have desalination-specific funding.

## **KEY ISSUES**

The need for new water supplies, abundance of saline and brackish water resources, and opportunities notwithstanding, there are important challenges to implementing desalination in Texas.

### **Seawater desalination**

One of the early challenges in seawater desalination was assessing the feasibility of seawater desalination as a practical, cost-effective water supply option and then proving the technical feasibility of implementing this technology in Texas.

In 2003, the TWDB funded three studies (Brownsville Public Utilities Board, City of Corpus Christi, and Brazos River Authority) to identify candidate sites and their feasibility for seawater desalination. The three studies concluded that implementing seawater desalination in Texas was technically feasible. With the aid of \$3.1 million appropriated by the 79th Texas Legislature in 2005, the TWDB also funded two pilot plant studies (Brownsville Public Utilities Board and Laguna Madre Water District) and environmental scoping studies. In 2010, the TWDB exhausted funds appropriated by the 79th Texas Legislature for seawater desalination demonstration activities. Since then, the TWDB has not funded seawater desalination studies.

Presently, there are no seawater desalination plants in Texas. While the pilot plant study conducted for the Brownsville Ship Channel project concluded that desalinating seawater was technically feasible, the challenge to implementing the project was, and remains today, financial. Over the past few years, the Brownsville Public Utilities Board has explored increasingly smaller project formats to reduce the financial impact to its ratepayers and to the state. At South Padre Island, voters, in May 2011, authorized Laguna Madre Water District to issue bonds to finance construction of a 1 million-gallon-per-day seawater desalination production facility with an estimated cost of \$13.2 million. Assuming that the Laguna Madre Water District can sell the necessary bonds, funding to implement the project at its currently proposed scale is not a challenge.

In the 2012 State Water Plan, seawater desalination is projected to produce about 125,514 acre-feet per year of new water by 2060—about 1.5 percent of the volume from all recommended water management strategies. Three regional water planning groups (H, L, and M) that have direct access to the Gulf of Mexico have recommended seawater desalination as a water management strategy in their plans.

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<sup>1</sup> Includes projects funded prior to 2000 but completed after 2000.

### Brackish groundwater desalination

Currently, there are 34 municipal brackish groundwater desalination facilities in Texas with a production capacity of more than 0.025 million gallons per day accounting for a total design capacity of approximately 73 million gallons per day (81,760 acre-feet per year). Among the brackish groundwater desalination facilities, El Paso Water Utilities' Kay Bailey Hutchison Desalination facility has the highest design capacity in the state (27.5 million gallons per day or 30,800 acre-feet per year). In total, the state has a desalination design capacity of approximately 123 million gallons per day.

In the 2012 State Water Plan, five regional water planning groups have recommended brackish groundwater desalination as a water management strategy to meet at least some of their projected water needs. In total, the regional water planning groups project that desalting brackish groundwater can create about 181,568 acre-feet of new water per year by 2060 accounting for two percent of all recommended water management strategies.

The principal challenges in brackish groundwater desalination include lack of knowledge about the brackish aquifers in the state; limited options for practical cost-effective methods to manage the desalination concentrate especially from larger plants; and the need for financial assistance for facility planning, pilot studies, and technology demonstration efforts. The TWDB-funded demonstration projects and other related studies have been addressing these challenges.

Although the types of projects that TWDB has funded span a wide range of topics, the projects are intended to address specific challenges to implementing desalination. Key categories of funded projects include:

- Guidelines for implementing desalination projects
- Feasibility studies
- Economics of desalination
- Regional water facility planning studies
- Database of desalination systems
- Pilot plant studies
- Resource characterization
- Energy use optimization
- Concentrate management
- Alternative energy sources
- Technology demonstration projects

After completing the projects, all final reports are made available through the agency's newsletters and Website and also occasionally presented in professional conferences.

All of these efforts have helped maintain and increase awareness of desalination statewide. However, the acceptance of desalination as an alternative source of new water supply needs to occur at the local level, by the entity and consumers that would benefit from new water supplies from desalination. Addressing local needs for objective information about long-term drought-proofing benefits of desalination requires facility planning studies and, in some cases, pilot plant and technology demonstration studies. Eleven of the 27 applications submitted in response to the TWDB's last three requests for proposals for desalination demonstration projects corresponded to these types of studies. Providing financial assistance for these types of studies will remain a critical factor in assisting communities become comfortable with desalination technologies and assess the local benefits of desalination.

The lack of knowledge on brackish water sources, especially brackish aquifers, is a big hurdle to implementing desalination projects. Given its complexity and cost, brackish aquifer characterization is particularly challenging for smaller utilities considering desalination. In 2009, the Texas Legislature provided TWDB two new positions and \$600,000 to fund research projects to establish and support the Brackish Resources Aquifer Characterization System program. TWDB funded three projects that were completed in 2011 and 2012. In further support of the brackish-aquifer mapping program, the 83<sup>rd</sup> Texas Legislature, 2013, provided two new staff to TWDB to continue and accelerate the mapping of brackish aquifers.

Since 2009, TWDB staff have been obtaining, cataloging, and analyzing thousands of geophysical and water well logs as part of the brackish aquifer mapping program. In September 2011, TWDB staff completed a full characterization of the Pecos Valley Aquifer in West Texas. This study report is now being considered by the City of Odessa and the Colorado River Municipal Water District in their planning for desalination water supplies. We are currently completing three other projects including a study of the Gulf Coast Aquifer in a four-county area in the Lower Rio Grande Valley area. We plan to complete the reports in spring 2014.

Although there are promising technologies being developed to aid in the management of desalination concentrate, for the foreseeable future the practical options include discharge into a surface body of water or wastewater collection system, underground injection, and disposal in an evaporation pond or by land application. Toward this end, TWDB is currently funding a project to assess the regulatory viability of and the process for disposing nonhazardous desalination concentrate into existing Class II injection wells through a dual Class I-Class II General Permit. The report will be available in spring 2014. The TWDB has played an important role in exploring and demonstrating cost-effective concentrate management options. Additional work is needed to resolve regulatory roadblocks for brine disposal options that are technically feasible and cost-effective.

In addition to funding appropriated by the legislature, TWDB staff has sought other funding and partnering opportunities to advance desalination. Examples of these efforts include current studies with the U.S. Bureau of Reclamation to pilot and assess the feasibility of variable salinity processes and, more recently (2012-2013), preparing guidance for rapid assessment and implementation of temporary emergency supplies using desalination.

In 2010, TWDB in partnership with the San Antonio Water System, U.S. Bureau of Reclamation, and other stakeholders organized a seminar on innovative water technologies showcasing many of TWDB's funded desalination studies and projects. Staff also organized a desalination roundtable in Austin in 2012.

The Board has led the state's effort to advance the development of desalination water supplies. Continued efforts to advance desalination in Texas will require financial assistance for facility planning, pilot and technology demonstration studies, improving the knowledge of brackish aquifers of the state, and working with key stakeholders to address regulatory roadblocks to concentrate management.

Attachment(s): Desalination Projects Funded by the Texas Water Development Board since 2000

Desalination Projects funded by the Texas Water Development Board since 2000  
(projects are grouped into seawater and brackish groundwater and arranged in reverse chronological order of completion)

Grant Recipient And Project Title	Short Description and Project Status	TWDB Grant Amount (\$)	Total Project Cost (\$)
<b>Seawater Desalination Projects</b>			
Laguna Madre Water District  <i>Seawater desalination pilot plant study</i>	A 12-month pilot plant study was conducted to collect source water quality data to determine the cost of a 1-million gallon per day full-scale facility and to update a regional water facility plan.  <i>Project status: Completed August 2010</i>	\$231,000	\$779,000
Brownsville Public Utilities Board  <i>Research and development permitting process strategies for seawater desalination projects in Texas</i>	The study included a comprehensive stakeholder scoping of issues associated with the design and development of seawater desalination facilities in Texas.  <i>Project status: Completed February 2009</i>	\$60,100	\$68,100
City of Brownsville  <i>Brownsville large-scale seawater desalination pilot plant study</i>	A 12-month pilot study was conducted to support the design, funding, and construction of a large-scale seawater desalination plant.  <i>Project status: Completed October 2008</i>	\$1,340,000	\$2,225,368.38
The University of Texas at Austin  <i>Desalination brine discharge modeling</i>	The study was conducted to investigate an existing high salinity outflow from a small embayment (Oso Bay) into a larger embayment (Corpus Christi Bay).  <i>Project status: Completed August 2006</i>	\$50,000	\$50,000

<b>Grant Recipient And Project Title</b>	<b>Short Description and Project Status</b>	<b>TWDB Grant Amount (\$)</b>	<b>Total Project Cost (\$)</b>
Brazos River Authority  <i>Freeport desalination plant feasibility study</i>	The study evaluated the feasibility of developing a seawater desalination plant at Freeport to provide the regional water planning area with an alternative source of potable water.  <i>Project status: Completed November 2004</i>	\$499,848	\$499,848
Brownsville Public Utilities Board  <i>Lower Rio Grande Valley Brownsville seawater desalination feasibility study</i>	The study evaluated the feasibility of building a seawater desalination facility in the Lower Rio Grande Valley region.  <i>Project status: Completed November 2004</i>	\$500,000	\$500,000
City of Corpus Christi  <i>Large scale demonstration desalination feasibility study</i>	The study evaluated the feasibility of building a seawater desalination facility in the Corpus Christi area.  <i>Project status: Completed November 2004</i>	\$500,000	\$500,000
R. W. Beck, Inc.  <i>Guidance manual for permitting requirements in Texas for desalination facilities</i>	The study developed a guidance manual for local communities and other stakeholders interested in planning for or implementing drinking water desalination projects.  <i>Project status: Completed November 2004</i>	\$50,000	\$50,000

<b>Grant Recipient And Project Title</b>	<b>Short Description and Project Status</b>	<b>TWDB Grant Amount (\$)</b>	<b>Total Project Cost (\$)</b>
<p>Lavaca Regional Water Planning Group</p> <p><i>Investigation of Joslin steam electric station for co-location of a desalination facility</i></p>	<p>Lavaca Regional Water Planning Group conducted a study to identify the most cost-effective, environmentally responsible process for desalinating seawater to provide a drought-proof water supply for potential application in the South Central Texas Region L (including San Antonio) and Region N (including the Corpus Christi area).</p> <p><i>Project status: Completed September 2000</i></p>	\$271,724	\$271,724
<p>Nueces River Authority</p> <p><i>Desalination for Texas Part A: membrane technologies cost Part B: economic importance of siting factors for seawater desalination</i></p>	<p>The study reviewed factors impacting siting decisions of seawater desalination facilities for the Texas coast.</p> <p><i>Project status: Completed August 2000</i></p>	\$50,000	\$50,000
<b>Brackish Groundwater Desalination Projects</b>			
<p>CDM Smith Inc.</p> <p><i>Permitting guidance manual to dispose desalination concentrate into a Class II injection well</i></p>	<p>The study is developing an instruction manual and road map for permitting a Class II well for dual Class I-Class II purposes.</p> <p><i>Project status: Ongoing--scheduled to be completed in spring 2014</i></p>	\$130,000	\$280,000
<p>City of Seminole</p> <p><i>An integrated wind-water desalination demonstration project for an inland municipality</i></p>	<p>The City of Seminole plans to desalinate brackish water from the Dockum Aquifer in Gaines County using wind energy for municipal use.</p> <p><i>Project status: Ongoing--scheduled to be completed in summer 2014</i></p>	\$300,000	\$1,625,000

<b>Grant Recipient And Project Title</b>	<b>Short Description and Project Status</b>	<b>TWDB Grant Amount (\$)</b>	<b>Total Project Cost (\$)</b>
Carollo Engineers  <i>Developing practical alternatives to pilot plant studies</i>	The project evaluated alternatives to the current regulatory requirement for pilot testing for reverse-osmosis brackish groundwater desalination projects.  <i>Project status: Completed January 2014</i>	\$150,000	\$193,000
City of Kenedy/San Antonio River Authority  <i>Demonstration of the efficiencies gained by utilizing improved reverse osmosis technologies</i>	The project demonstrated the efficiencies gained by installing a new reverse osmosis system in an existing brackish groundwater desalination plant.  <i>Project status: Completed August 2013</i>	\$150,000	\$730,300
North Alamo Water Supply Corporation  <i>Demonstration of fiberglass well casings in brackish groundwater wells</i>	The project demonstrated the technical and economic viability of using fiberglass well casing in water wells installed in brackish aquifers.  <i>Project status: Completed June 2013</i>	\$100,000	\$787,500
Texas Tech University  <i>Demonstration of a high recovery and energy efficient RO system for small-scale brackish water desalination</i>	The study demonstrated the use of a reverse osmosis system with parallel elements for small-scale desalination with high recovery and energy efficiency.  <i>Project status: Completed April 2013</i>	\$101,597	\$194,609
Carollo Engineers  <i>Upflow calcite contactor design</i>	The study developed design criteria for the post-treatment of permeate water using an upflow calcite contactor.  <i>Project status: Completed April 2012</i>	\$188,403	\$211,091



<b>Grant Recipient And <i>Project Title</i></b>	<b>Short Description and <i>Project Status</i></b>	<b>TWDB Grant Amount (\$)</b>	<b>Total Project Cost (\$)</b>
Bureau of Economic Geology  <i>Compilation and scanning of well log database</i>	As part of the project, geophysical well logs from brackish aquifers in the state were collected from multiple sources, digitized, and the information entered into a database.  <i>Project status: Completed March 2012</i>	\$300,000	\$300,000
CH2M Hill  <i>An assessment of osmotic mechanisms pairing desalination concentrate and wastewater treatment</i>	The study investigated the use of reverse osmosis concentrate as a draw solution in a forward osmosis process for recovering water from wastewater.  <i>Project status: Completed November 2011</i>	\$90,000	\$135,583
El Paso Water Utilities – Public Service Board  <i>Pilot Study to demonstrate volume reduction of reverse osmosis concentrate</i>	Using the concentrate from the KBH Brackish Groundwater Desalination plant, the study evaluated silica reduction in reverse osmosis concentrate through the addition of lime, and application of the Vibratory Shear Enhanced Process. A second phase of the project tested the use of seawater reverse osmosis membranes to increase water recovery.  <i>Project status: Completed November 2011</i>	\$228,557	\$505,982
Intera  <i>Brackish aquifer modeling</i>	The study assessed groundwater modeling approaches for brackish aquifers.  <i>Project status: Completed November 2011</i>	\$50,000	\$60,000
Intera  <i>Brackish aquifer bibliography</i>	A comprehensive bibliography of Texas brackish aquifers was developed for the project.  <i>Project status: Completed November 2011</i>	\$99,500	\$99,500

<b>Grant Recipient And Project Title</b>	<b>Short Description and Project Status</b>	<b>TWDB Grant Amount (\$)</b>	<b>Total Project Cost (\$)</b>
Affordable Desalination Collaboration  <i>Energy optimization of brackish groundwater desalination</i>	This study assessed and demonstrated energy optimization strategies for brackish groundwater desalination by reverse osmosis.  <i>Project status: Completed September 2011</i>	\$496,783	\$1,356,683
San Antonio Water System (SAWS)  <i>Evaluation of concentrate management and assessment of the Vibratory Shear Enhanced Process</i>	SAWS conducted a pilot test to assess the cost and technical feasibility of the Vibratory Shear Enhanced Process as a tool for reducing the volume of desalination concentrate.  <i>Project status: Completed October 2010</i>	\$205,000	\$877,000
The University of Texas – Austin  <i>Improving recovery: A concentrate management strategy for inland desalination</i>	The study investigated anti-scalant precipitation, and electrodialysis to increase recovery in reverse osmosis desalination of brackish groundwater.  <i>Project status: Completed August 2010</i>	\$238,500	\$323,010
Bureau of Economic Geology  <i>Self-sealing evaporation ponds for desalination facilities in Texas</i>	The study investigated regulatory requirements for developing a self-sealing evaporation pond.  <i>Project status: Completed January 2009</i>	\$49,928	\$49,928
North Cameron Regional Water Supply Corporation  <i>Brackish groundwater desalination guidance manual</i>	The project involved preparing a brackish groundwater desalination guidance manual using the North Cameron Regional Water Supply Corporation's desalination plant in Cameron County as an example.  <i>Project status: Completed July 2008</i>	\$150,000	\$735,000

<b>Grant Recipient And <i>Project Title</i></b>	<b>Short Description and <i>Project Status</i></b>	<b>TWDB Grant Amount (\$)</b>	<b>Total Project Cost (\$)</b>
City of San Angelo/Upper Colorado River Authority  <i>Assessment of the Whitehorse aquifer as a potential source of water supply for the City of San Angelo</i>	The project assessed the feasibility of the Whitehorse aquifer in Irion County as a source of brackish water that can be desalinated and used by the City of San Angelo for municipal purposes.  <i>Project status: Completed May 2008</i>	\$300,000	\$549,200
Bureau of Economic Geology  <i>Development of a desalination database for Texas</i>	The study developed a desalination database for Texas.  <i>Project status: Completed October 2005</i>	\$75,000	\$75,000
LBG-Guyton Associates  <i>Brackish groundwater manual for Texas regional water planning groups</i>	The study was conducted to identify potential brackish groundwater sources in Texas for future potable use.  <i>Project status: Completed February 2003</i>	\$99,940	\$99,940